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(19)(CA) **APPLICATION FOR CANADIAN PATENT** (12)

(54) Centrifugal Separator

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CENTRIFUGAL SEPARATOR

ABSTRACT OF THE DISCLOSURE

A centrifugal separator comprises a bowl with a peripheral wall on which is provided a plurality of axially spaced rings defining between each ring and the next a V-shaped recess into which the heavier materials collect. At the base of each recess is provided a plurality of angularly spaced openings through which fluidizing water is injected from a jacket surrounding the bowl to maintain the material within the recess fluidized. A screen material is located across the recess so as to divide the recess into an inner shallower recess and an outer chamber between the screen material and the base of the recess. The fluidizing water is fed through a shaft to a hub supporting the jacket and bowl and the bowl, when halted, discharges also through ducts in the hub from a conical opening at the base of the bowl. The rings and recesses are molded into a liner attached to the bowl by punched U-shaped members in the metal liner of the bowl through which the openings pass.

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CENTRIFUGAL SEPARATOR

BACKGROUND OF THE INVENTION

This invention relates to a centrifugal separator of the type comprising a centrifuge bowl around which is provided a jacket for supply of feed water to the area between the jacket and the bowl for supplying fluidizing water into the bowl and particularly to a discharge arrangement for discharging the collected materials from the bowl after processing of a batch of materials.

A centrifugal separator manufactured in accordance with a design of the present inventor is shown for example in U.S. Patent 4,846,781 issued July 11, 1989. In the design shown in this patent the present inventor has taken careful steps by the design of the bowl and injection of fluidizing water from the jacket into the bowl to maximize the efficiency of separation which occurs within the bowl.

One problem which has arisen in view of the design of this bowl is that of providing effective discharge of the collected material from the grooves in the bowl once a batch of material has been processed and the bowl halted. it will be appreciated that the separator of the type snown is a batch type separator in that a quantity of material is processed and the heavier or higher specific gravity materials are collected between the grooves in the bowl until the grooves are effectively filled with the separated materials. Once this occurs it is necessary to halt the processing and to wash down the material for collection at the base of the bowl.

In the design using a surrounding water jacket for the injection of fluidizing water into the bowl through openings at the base of the groove, it is difficult to provide a discharge opening. This problem arises since the water for the water jacket is supplied through the shaft which supports the bowl for rotation. The shaft is generally attached to a hub which is itself attached to the base of the water jacket and

hence there is no room available for the discharge at that point. The discharge of the above design is therefore offset to one side and is located under the lowermost one of the grooves at the peripheral wall of the bowl. This location has however provided difficulties in washing down the material from the bowl in that the material tends to collect on the base and is reluctant to move to the discharge opening.

Another design of separator which uses the water jacket principle is shown in Australian application number 22055/35 of MacNicol which was published in 1936. In this arrangement, the water is supplied along the shaft supporting the bowl and is connected to the water jacket by a plurality of pipes extending from the shaft to the base of the jacket which extends only over the peripheral wall. The outlet for the discharge of the materials from the bowl is arranged as a plurality of openings at spaced positions around the hub connecting the shaft to the base of the bowl. This arrangement is completely impractical since the positioning of the openings will cause materials to be expelled from the base through those openings during normal processing without the materials passing over the separation area. Furthermore the connection of the feedwater through individual pipes is impractical due to the fact that the pipes are very vulnerable to damage and particularly to wear during the engagement of those pipes with the highly abrasive materials to be separated while the pipes are rotated about the axis at high velocity. This patent also shows an arrangement in which a screen material is arranged to cover the inner surface of the drum and particularly the holes through which the water is injected.

SUMMARY OF THE INVENTION

It is one object of the present invention therefore to provide a centrifuge apparatus of this general type including a bowl and a surrounding water jacket in which the discharge of collected materials, with the centrifugal action halted,

can be effectively carried out through the base of the bowl.

It is a further object of the present invention to provide a centrifuge apparatus of this type which can be used as a final separator to generate a ratio of gold to unwanted ore of greater than 50%.

It is a yet further object of the present invention to provide a technique for attachment of the liner to the peripheral wall of the bowl which decreases the risk of separation therebetween.

According to the invention, therefore, there is provided apparatus for centrifugally separating intermixed materials of different specific gravities comprising a centrifuge bowl having a base and a peripheral wall generally upstanding from the base to an open mouth and surrounding an axis passing through the base, a plurality of openings passing through the peripheral wall, a jacket having a sleeve portion surrounding the peripheral wall so as to define a sleeve-shaped channel therebetween and a base portion underlying the base of the bowl and spaced therefrom so as to define between the base and the base portion a liquid receiving area for receiving liquid communicated to the liquid receiving area under pressure for passage to the sleeve-shaped channel to pass through the openings into the bowl, means connecting the bowl and jacket for common rotation about the axis, a support member for the bowl and jacket for supporting and driving said bowl and jacket in said rotation, said support member including a shaft extending coaxially of said axis away from said base and means mounting the shaft for rotation about said axis, a stationary feed duct extending through said open mouth separate from said shaft for feeding material to be separated into said bowl such that the materials pass therefrom onto the peripheral wall for materials of higher specific gravity to be collected by centrifugal action on the peripheral wall of the bowl while materials of lower specific gravity escape through the

open mouth, supply means including a hollow interior of the shaft for supplying liquid through the base portion of the jacket into the liquid receiving area between the base portion and the base of the bowl and discharge means for discharging, with said centrifugal action halted such that the collected materials are washed down from the peripheral wall to the base, said collected materials from the bowl, said discharge means comprising duct means communicating with said base of said bowl and extending through the liquid receiving area between the base of the bowl and the base portion for discharge into an area beneath the base portion for collection, the duct means and the base defining surfaces for engaging the collected washed down materials which surfaces are substantially all inclined to the horizontal at an angle sufficient that the collected washed down materials can flow under their own momentum from the bowl through the duct means.

According to a second aspect of the invention, there is provided a centrifuge bowl comprising an outer shell formed from a rigid supporting material including a peripheral wall surrounding an axis of the bowl about which the bowl can rotate to centrifuge materials carried on the peripheral wall, and an inner liner of a cast plastics material mounted on the peripheral wall for rotation therewith, means defining a plurality of ducts through the peripheral wall each communicating from an open mouth at an inner surface of the liner to an open mouth at an outer surface of the peripheral wall, and a plurality of attachment means for attachment of the inner liner to the peripheral wall, each attachment means comprising a portion of the peripheral wall which is punched inwardly of the peripheral wall towards the axis, said portion defining a U-shaped channel having a base and two legs with the base of the U-shape facing inwardly and the legs of the U-shape integrally attached to the peripheral wall, ends of the channel being open by a severing of the material of the peripheral wall at

the ends of the portion, and an insert portion of the cast plastics material of the inner liner which is integral with the inner liner and which extends from the inner liner on the inner surface of the peripheral wall through the ends of the channel and along the channel such that the insert portion lies exteriorly of the portion of the peripheral wall, each of at least some of said ducts extending through the insert portion generally longitudinal of the channel and through one of the ends of the channel.

According to a third aspect of the invention there is provided an apparatus for centrifugally separating intermixed particulate materials of different specific gravities in a liquid comprising a centrifuge bowl having a base and a peripheral wall surrounding an axis passing through the base and generally upstanding from the base to an open mouth, axially spaced, inwardly projecting, peripherally extending ring members defined on an inner surface of the peripheral wall so as to provide an annular recess between each ring member and the next adjacent ring member, and a plurality of openings extending through the peripheral wall from an outer surface to the inner surface thereof, the openings being arranged in the recess between each ring member and the next adjacent ring member and in spaced relation around the peripheral wall, means mounting the bowl for rotation about the axis, means for feeding materials into the bowl such that during rotation of the bowl the materials flow over the peripheral wall for discharge from the open mouth, means for applying fluidizing liquid to the outer surface of the bowl so as to pass through the openings and fluidize the materials in the recesses, and a plurality of substantially annular portions of a screen material each extending across a respective one of the recesses at a position spaced radially outwardly from an innermost edge of each of the adjacent ring members, so as to define a: shallower recess having a base formed by the screen material and sides formed by those portions of the ring members radially inward of the

screen material, and spaced radially inwardly of the peripheral wall, so as to define an annular channel between the screen material and the peripheral wall, the openings discharging into the channel.

One or more embodiments of the invention will now be described in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a vertical cross sectional view through a centrifugal separator according to the present invention.

Figure 2 is a cross sectional view of a part of the apparatus of Figure 1 showing particularly the connection between the base of the bowl, the base portion of the outer jacket, the shaft and the support hub of the shaft.

Figure 3 is a view along the lines 3-3 of Figure 2.

Figure 4 is a cross sectional view of the support hub and shaft only of Figure 2, the cross section being taken at right angles to the cross section of Figure 2.

Figure 5 is a cross-sectional view similar to that of Figures 1 and 2 showing an alternative arrangement of discharge arrangement for the bowl.

Figure 6 is a cross-sectional view through one portion of the bowl of Figure 1, the cross-section being taken along the lines 6-6 of Figure 7;

Figure 7 is a cross-sectional view along the lines 7-7 of Figure 6;

Figure 8 is a cross-sectional view taken along the lines 8-8 of Figure 6, the cross-section being taken prior to the casting of the inner liner so as to show only the structure of the outer shell;

Figure 9 is a cross-sectional view taken along the lines 7-7 of Figure 6 again showing only the outer shell prior to the casting of the inner liner;

Figure 10 is a cross-sectional view along the lines 10-10 of Figure 7;

Figure 11 is a vertical cross-sectional view similar to that of Figure 1 taken on an enlarged scale and showing the mounting of the screen material within the recess.

In the drawings like characters of reference indicate corresponding parts in the different figures.

DETAILED DESCRIPTION

The centrifuge apparatus is generally of the type shown for example in the above mentioned U.S. Patent 4,846,781 of the present inventor. In general terms, therefore, the apparatus comprises a centrifuge bowl 10 having a base 11 and an upstanding side wall 12 for rotation about an axis 13. The peripheral wall has openings 14 through which water can be injected from the water receiving area 15 of a water jacket 16. The jacket includes a base portion 17 and a peripheral wall 18, the latter being cylindrical in shape and the former being a substantially flat disk welded at its peripheral edge to the base of the sleeve 16.

The bowl and the jacket are mounted for rotation about a shaft generally indicated at 19 which is mounted on bearings 20 for rotation about the axis 13. The shaft is driven by a motor 21 through a belt and pulley arrangement.

The bowl and the jacket are mounted within a housing 22 which defines a collecting launder 23 for material which escapes from the open mouth of the bowl after passage over the peripheral wall for separation. The material is fed into the bowl by a duct mounted on the housing 22 and extending along the axis 13 as a fixed supply duct 24 extending toward the base 11 of the bowl.

The above details are shown in the above previous patent of the

present inventor together with a number of other previous patents of the inventor which describe various details of the machine.

The details of one modification of the present invention are shown best in Figures 2, 3 and 4. In this arrangement, the base 11 of the bowl is, instead of the simple flat base of the prior art device, shaped to form a conical base section 25 which is welded to a narrow annular ring 11A forming an initial part of the base. The conical base portion converges inwardly and downwardly to a discharge opening 26 arranged coaxially with the axis 13. On top of the welded conical portion 25 is attached a liner of a suitable wear resistant plastics material 27. The liner extends from the lower most ring 28 of the bowl over the edge of the ring 11A and down across the conical portion to the discharge opening 26.

Above the plane of the ring 11A is mounted a base plate 30 which is simply a flat disc of circular plan view covered by a wear resistant layer 31 on the upper surface. The disc is mounted by a plurality of support elements 32 which extend from the underside of the plate outwardly and downwardly into engagement with the sides of the conical portion 25 to which the plate is attached by bolts 33. The outside periphery of the base plate 30 is less than the periphery of the lower most ring 28 so that there is an annular space between these elements which will allow material to fall downwardly under the action of gravity. The outside periphery of the base plate 30 is however significantly greater than the diameter of the discharge opening 26. In this way in normal centrifuging operation of the device, the feed material from the duct 24 is deposited onto the wear resistant layer 31 and from there moves outwardly toward the peripheral wall of the bowl. As the material moves outwardly it also accelerates to rotate at a speed approaching that of the angular velocity of the bowl so there becomes on the materials a relatively high centrifugal force up to the order of 25G. Under these

centrifugal forces, the materials generally cannot fall vertically downwardly into the annular space between the base plate and the ring 28 but instead is flung outwardly into the ring 28 where an initial separation of the materials occurs following which the materials pass over the remaining rings of the bowl to be discharged from the open mouth. Any materials that do move downwardly into the area beneath the base plate engage the inwardly converging conical liner member 27 and thus are forced upwardly and outwardly relative to this liner due to the high centrifugal forces in this area. The materials certainly therefore cannot reach the discharge opening 26 during the normal processing. However the angle of the wall or liner member 27 is such that the materials flow out of the bowl in the water flow without bridging.

At the bottom end of the conical portion 25 is welded a short cylindrical section 35 which is coaxial to the axis 13. This cylindrical section 35 projects outwardly just beyond a lower most edge 27A of the liner with the liner turning around and over the junction between the conical portion 25 and the cylindrical portion 35.

At the end of the shaft 19 is mounted a hub member 40 which is welded to the shaft and provides connection between the shaft and the bowl. The hub member includes a first cylindrical portion 41 and a second portion which is conical in shape and diverges outwardly from the first cylindrical portion 41 to a second cylindrical portion 43. The conical portion indicated at 42 thus increases in diameter from the portion 41 just surrounding the shaft to the larger diameter of the portion 43 which provides an upper plate 44 which is generally flat for engaging against the bottom surface of the base portion 17 of the jacket. The hub member is generally a solid body to provide structural strength for connection of the shaft to the base portion or plate 17 to hold the bowl and jacket in the cantilever arrangement during rotation at

the high velocity necessary to provide the centrifugal forces required for proper separation.

The upper plate 44 of the hub member includes a raised ring 45 adjacent an inner part of the upper plate of diameter just greater than that of the shaft 19. The raised ring 45 provides a shoulder for receiving an opening 46 in the base plate 17 of the jacket. The shoulder is welded to the inner edge of the opening as indicated at 47 to connect the base plate and the hub member. An annular recess 48 is provided in the raised portion 45 with a bead of a sealing material 49 provided in the recess for engaging against the end face of the cylindrical portions 35 of the bowl. The bowl is thus formed as a separate element which is attached to the outer jacket by insertion of the bowl into the outer jacket, the location of the cylindrical portion 35 into the recess 48, and the clamping of an upper flange 50 of the bowl by bolts 51 to a cooperating flange 52 of the jacket.

The hub member 40 is arranged and machined to provide communication of discharge materials out through the opening 26 into the shaft and at the same time the supply of feed water from the shaft 19 into the interior of the jacket.

Thus the shaft 19 includes a central hollow duct 53 through which the water is supplied from a connection 54 at the lower end of the shaft. The water thus flows along the hollow interior of the shaft 19 from the bottom upwardly toward the jacket.

The shaft 19 at its upper end cooperates with the opening 26 and has a diameter substantially equal to the opening 26 so the materials flowing out of the bowl, when the centrifugal action is halted, escape into the shaft 19 at its upper portion indicated at 54.

The hollow section of the shaft 53 communicates with the interior

of the jacket through a pair of drilled holes 56 and 57 best shown in Figure 4. These drilled holes are drilled through the plate 17 as indicated at drilled portions 56A and 57A and through the hub member to intersect with the hollow interior 53 of the shaft.

The drilled holes 56 and 57 thus extend from the hollow interior of the shaft 53 and diverge upwardly and outwardly at diametrically opposed locations so as to bypass and be physically disconnected from the hollow section 54 of the shaft at the upper part of the shaft.

Symmetrically but in opposite direction, the hollow interior portion 54 of the shaft is connected to a pair of ducts 58 and 59 which are drilled through the hub member from the conical surface 42 in a direction inclined inwardly and upwardly toward the axis 13 so as to break out in the hollow area 54. As best shown in Figure 3, the ducts 58 and 59 are arranged in diametrically opposed position and arranged at 90° relative to the ducts 56 and 57 so that there is no interconnection between the ducts and there is sufficient material remaining in the hub member to provide the required structural strength for the hub member.

The holes 56 and 57 are drilled of sufficient diameter to allow communication of the required amount of water from the interior 53 of the shaft into the interior of the jacket for supply of fluidization water into the bowl. The materials from the recesses can wash wholly out of the bowl without manual assistance due to the downwardly inclined angle of the discharge opening walls which are arranged to prevent bridging and due to the high f' 'ates through the ducts 58 and 59.

The ducts 58 and 59 and the discharge opening are continually open and thus have no plug to be removed or opened during the discharge process.

Similarly the ducts 58 and 59 are of sufficient diameter to exceed in total area the area of the outlet 26 *so* that material washed through the outlet 26 can

be carried away through the ducts 58 and 59 to escape from the outside surface of the hub member.

For collection of the discharged materials, there is provided a generally dome shaped cap 60 which sits over the bearing 20 and is attached to the hub member for rotation therewith. The dome shape cap 60 covers an inner launder surface 61 which extends downwardly and outwardly from the underside of the cap. The bottom of the conical launder wall 61 communicates toward an inclined launder base plate 62 which extends downwardly toward one side of the housing 22 to a discharge duct 63. An inner wall 64 of the outer launder for the main discharge materials separates the inner launder for the collected materials from the outer launder for the discharged materials or gangue.

In operation, the machine is operated in batch mode so that it is operated for a selected period of time to process a particular predetermined quantity of materials. The materials are separated in the conventional manner with the feed material entering the bowl, being thrown outwardly onto the wall of the bowl, being separated across the wall of the bowl with the gangue being discharged to the open mouth to the launder and the heavier materials being collected on the wall. When the processing is complete, that is the maximum amount of material has been processed for efficient separation, the material feed through the duct 24 is halted and the liquid washing feed is reduced in pressure thus reducing the volume flowing through the openings into the bowl.

The bowl is then halted by disconnecting the drive from the motor and optionally the application of a brake. When the bowl is halted, the supply of water from the shaft interior 53 through the ducts 56 and 57 is restarted under normal pressure thus providing a vigorous washing action in the grooves which propels the

collected materials out of the grooves to fall to the bottom of the bowl. This material is then washed downwardly in the bowl and passes through the annular space between the base plate and the conical section of the bowl and thus is washed through the conical section and into the discharge opening 26. The escaping materials thus pass through the ducts 58 and 59 to the outside surface of the hub member at a position spaced from the interior 53 of the shaft so that they can be released into the inner launder for collection through the discharge duct 63.

The washing action takes place efficiently in view of the central discharge opening of the bowl. The special design of the hub member provides communication of the discharge materials from the base of the bowl, the supply of feed water into the interior of the jacket and the structural strength to support the bowl during its high velocity rotation.

In Figure 5 is shown an alternative arrangement in which the discharge arrangement for the bowl is modified relative to that shown in Figure 2. The remaining elements are effectively the same as the previous embodiment except that the support member 19 for the bowl is of the conventional type used on previous designs of the machine manufactured by the present inventor and shown in his previous patents in which the water, for supply to the jacket for feeding through the openings in the bowl is passed through the shaft and emerges from a feed opening 80 through the base portion of a jacket into the area between the base of the bowl and the base portion of the jacket.

In this case the discharge from the base of the bowl passes through ducts which extend from the base of the bowl through the space between the base of the bowl and the jacket, through the base portion of the jacket and into the area underneath the base portion of the jacket. The ducts are indicated at 81 and 82 and

these diverge outwardly from the underside of the bowl and particularly from the underside of the plate 30 previously described. The ducts 81 and 82 extend from a pair of recesses 83 and 84 attached to the underside of the bowl and defining walls which are inclined to the horizontal so as to allow the material to run from the base without bridging. In this way the material discharged from the bowl runs to the bottom of the bowl and enters the two recesses at 83 and 84 for discharge along the ducts 81 and 82. No plugs or closures for the ducts are required.

Turning now to the construction of the bowl, basically the bowl comprises the outer shell 10 having the base 11 and the peripheral wall 12 for rotation about the central axis 13 of the bowl. The shell has an outer surface 114 and an inner surface 115 and on the inner surface 115 is cast an inner layer or liner 116 of a cast plastics material. The plastics material is cast in place within the bowl and an inside surface 117 of the liner is shaped by a mold to provide a required inside surface shape. In the example shown the inside surface is molded to define annular rings 118 and recesses 119 which are arranged alternatively along the height of the peripheral wall for collection of material within the recesses with lighter materials tending to pass over the rings 118 to discharge from the mouth of the bowl during the centrifuge process.

A plurality of openings or ducts 120 (also indicated at 14 in Figure 1) are formed in the bowl so as to extend through the shell 10 at the peripheral wall 12 and through the inner liner 116 at the base of each of the recesses 119 to allow the injection of water from the outside of the bowl into the recesses for fluidization of the material as is fully explained in the above patent.

The formation of the shell and the manner of attachment of the cast in a liner to the shell is shown in Figures 6 through 10. In those Figures the location of one of the openings 120 is shown in enlarged cross sectional view but it will

be appreciated that each of the openings is of the construction shown in Figures 6 through 10 and thus the inner liner is attached to the shell at each of the opening locations.

Specifically at each intended opening location, tile wall is punched using a substantially cylindrical punch body which forms a channel portion 130 which projects from the peripheral wall to the inside of the peripheral wall towards the axis 13. The channel portion 130 is shown in cross section in Figure 9 and in end elevation of view in Figure 8 and is generally U-shaped with a base 131 projecting inwardly into the bowl and two legs 132 and 133 extending from the base toward the wall 12 and formed integrally with the wall 12 by the deformation obtained by the action of the punch on the wall 12. The ends of the channel portion 130 are severed from the material of the wall so as to form a substantially D-shaped opening 134, 135 at respective ends of the channel portion.

Subsequent to the formation of the punched channel portion as shown in Figure 8, a tape element 137 is applied across the recess thus formed on the outer side of the portion 130. The tape thus covers the recess and lies flushed with the outer surface 114 of the wall 12.

After the tape elements 137 are applied over each of the recesses thus formed, the inner layer of the cast plastics material is formed on the inside surface of the bowl by a conventional casting or molding action. As the channel portion 130 has open ends 134 and 135 by the severing of the material of the wall, the plastics material during the casting action passes through the openings 134 and 135 and thus fills the recess rearwardly of the channel portion to form an insert portion 140 which fills the recess rearwardly of the channel portion 130 to a position flush with the outer surface 114 of the wall as best shown in Figure 10. This insert portion 140 therefore

acts to grasp around the punched portion 130 and is of course integral with the remainder of the liner 116 thus physically attaching the liner 116 to the shell at tile punched portion 130. This position is best shown in Figures 7 and 10.

Subsequent to the completion of the casting of the material, the ducts or openings 120 are formed by drilling through the insert portion 140, through the end 134 of the channel portion and through the thickness of the liner 116 at the base of one of the recesses 119. The duct 120 is thus inclined to a radius of the axis 13 but all of the ducts 20 of one of the recesses 119 lie in a radial plane of the axis 13.

In this way the punched channel portion 130 and the insert portion 140 thus formed during the casting process serve two purposes. Firstly they cooperate to anchor the liner 116 to the shell at each of the openings 120. Secondly they provide a location for receiving the opening 120 which can be simply drilled through the relatively soft plastics material while the drilling action occurs at an angle to the surface which otherwise would be difficult if drilled through metal.

Returning now to Figures 1 and 11, a ring or annulus of screen material indicated at 200 is mounted in each recess 119 and extends across the recess. As shown in Figure 11, the screen material 200 is located at a position within the recess 119 spaced outwardly from an innermost edge 210 of the ring members 118 and spaced radially inwardly of the base 211 of the respective recess. This location forms a shallower recess 201 within the recess 119, the shallower recess 201 being defined by an inside surface 202 of each of the adjacent ring members 118 and by a base 203 formed by the outer surface of the screen material 200. The location of the screen material further defines a channel 204 between the base 211 and the outside surface of the screen material. The channel 204 is annular so that it fully surrounds the screen material and is fed with the fluidizing liquid which enters into the channel through the

openings 14 around the base 211. Thus the channel is fed by a number of such openings 14 at angularly spaced positions around the channel.

Different arrangements for mounting the screen material in the spaced position from the base 27 can be provided. In one example the screen material is attached to a pair of flanges 205 and 206 along each edge of the screen material and extending outwardly from that edge along the inside surface 212 of the adjacent ring 118 to the base 211. The screen material can thus be provided in an annular form which can be manufactured to the required size of the respective annular recess, which vary as can be seen from Figure 1. A full set of the screen material inserts can then be supplied for the bowl and inserted into place simply as a press fit with the screen material thus supported away from the base to the required distance.

The separator with the additional screen mesh inserts 200 is intended as a final separator in a process of repeated concentration.

Thus the concentration may commence with an initial ore having a quantity of gold of for example a few ounces per ton. A first concentration process using a machine of the general type shown in the above U.S. patent can be effected to provide a separation thus increasing the concentration of gold up to an amount of the order of 200 oz/ton. A subsequent separation may further increase the proportion of gold to 1500 to 1800 ozs/ton. A final separation using the device of the present invention can be used to provide a resultant batch product from the shallower recesses which has at least 50% gold and preferably of the order of 70 to 80% gold. This proportion is sufficiently high to enable the material to proceed from the separation to a smelting process generally without the use of the conventional toxic materials used in gold separation. In addition the use of the device of the present invention allows the high efficiency available with the centrifugal separation to be available throughout the

process and to avoid the use of the conventional table. The table can produce very high quantities of gold but at relatively low efficiency.

In the operation of the present invention, the particular materials in a water carrier are introduced through the feed duct 14 into the bowl. This material shown at 207 in Figure 11 passes over the recesses between the ring members 118 to escape from the open mouth. Within the shallower recesses 201 collects the required separated product 208 which is fluidized by the passage of the fluidizing water 209 through the perforations in the screen material. The screen material is selected to have perforations which are sufficiently large to allow the water 209 to pass through but sufficiently small to prevent the particles 208 to escape into the channel 204. The channel 204 thus remains empty of solids and acts simply as a water communication channel to allow the water to pass through into the fluidized bed throughout the whole of the base of the shallower recess to effect a stronger fluidization of the bed. In addition, the shallower groove structure prevents unwanted ore from entering the groove to a depth at which it cannot be removed by the fluidization and separation process. Little unwanted ore is therefore collected in the shallower groove at the start up of the device so that the proportion of gold within the material 208 is maximized while the separation is effected through the interface between the flowing materials and the material in the recess.

While the screen material may be less resistant to wear than the conventional machine, the reduced throughput of the final separation allows the machine to operate effectively.

CLAIMS:

1. Apparatus for centrifugally separating intermixed materials of different specific gravities comprising a centrifuge bowl having a base and a peripheral wall generally upstanding from the base to an open mouth and surrounding an axis passing through the base, a plurality of openings passing through the peripheral wall, a jacket having a sleeve portion surrounding the peripheral wall so as to define a sleeve-shaped channel therebetween and a base portion underlying the base of the bowl and spaced therefrom so as to define between the base and the base portion a liquid receiving area for receiving liquid communicated to the liquid receiving area under pressure for passage to the sleeve-shaped channel to pass through the openings into the bowl, means connecting the bowl and jacket for common rotation about the axis, a support member for the bowl and jacket for supporting and driving said bowl and jacket in said rotation, said support member including a shaft extending coaxially of said axis away from said base and means mounting the shaft for rotation about said axis, a stationary feed duct extending through said open mouth separate from said shaft for feeding material to be separated into said bowl such that the materials pass therefrom onto the peripheral wall for materials of higher specific gravity to be collected by centrifugal action on the peripheral wall of the bowl while materials of lower specific gravity escape through the open mouth, supply means including a hollow interior of the shaft for supplying liquid through the base portion of the jacket into the liquid receiving area between the base portion and the base of the bowl and discharge means for discharging, with said centrifugal action halted such that the collected materials are washed down from the peripheral wall to the base, said collected materials from the bowl, said discharge means comprising duct means communicating with said base of said bowl and extending through the liquid receiving area between the

base of the bowl and the base portion for discharge into an area beneath the base portion for collection, the duct means and the base defining surfaces for engaging the collected washed down materials which surfaces are substantially all inclined to the horizontal at an angle sufficient that the collected washed down materials can flow under their own momentum from the bowl through the duct means.

2. The apparatus according to Claim 1 wherein the discharge means includes a conical discharge area of the base converging downwardly and inwardly toward said axis to a discharge opening coaxial of said axis.

3. The apparatus according to Claim 1 or 2 wherein the support member includes a hub member connected to the shaft, each of said supply means and said discharge means including duct portions extending through said hub member with the duct portions of the supply means being angularly offset from the duct portions of the discharge means.

4. The apparatus according to Claim 3 wherein the hub member is attached to an underside of the base portion of the jacket.

5. The apparatus according to Claim 3 or 4 wherein the discharge means includes a discharge area of the base converging downwardly and inwardly toward said axis to a discharge opening coaxial of said axis and wherein the discharge means includes at least one duct portion extending through the hub member and extending outwardly from the axis and downwardly from the central discharge opening to escape from the hub member at a position thereon spaced from said axis and wherein the supply means includes at least one duct portion extending from the duct through the shaft and extending upwardly and outwardly from the axis through the hub member so as to extend from the hub member through the base portion of the jacket to supply said liquid into said liquid receiving area.

6. The apparatus according to Claim 3, 4 or 5 wherein the bowl includes a base member positioned above said discharge opening and providing an opening around the base member, the diameter of the base member being greater than that of the discharge opening.

7. The apparatus according to any preceding claim wherein the bowl comprises an outer shell formed from a rigid supporting material including a peripheral wall and an inner liner of a cast plastics material mounted on the peripheral wall for rotation therewith, each of said openings in the peripheral wall defining a duct through the peripheral wall communicating from an open mouth at an inner surface of the liner to an open mouth at an outer surface of the peripheral wall, and a plurality of attachment means for attachment of the inner liner to the peripheral wall, each attachment means comprising a portion of the peripheral wall which is punched inwardly of the peripheral wall towards the axis, said portion defining a U-shaped channel having a base and two legs with the base of the U-shape facing inwardly and the legs of the U-shape integrally attached to the peripheral wall, ends of the channel being open by a severing of the material of the peripheral wall at the ends of the portion, and an insert portion of the cast plastics material of the inner liner which is integral with the inner liner and which extends from the inner liner on the inner surface of the peripheral wall through the ends of the channel and along the channel such that the insert portion lies exteriorly of the portion of the peripheral wall, each of said ducts extending through the insert portion generally longitudinal of the channel and through one of the ends of the channel.

8. The apparatus according to any preceding claim including axially spaced, inwardly projecting, peripherally extending ring members defined on an inner surface of the peripheral wall so as to provide an annular recess between each ring

member and the next adjacent ring member, said openings being arranged in the recess between each ring member and the next adjacent ring member and in spaced relation around the peripheral wall, and a plurality of substantially annular portions of a screen material each extending across a respective one of the recesses at a position spaced radially outwardly from an innermost edge of each of the adjacent ring members, so as to define a shallower recess having a base formed by the screen material and sides formed by those portions of the ring members radially inward of the screen material, and spaced radially inwardly of the peripheral wall, so as to define an annular channel between the screen material and the peripheral wall, the openings discharging into the channel.

9. The apparatus according to Claim 8 wherein the annular channel is continuous around each recess and wherein the openings pass through the side wall in a direction inclined to a radius of the axis so as to direct the fluidizing liquid angularly around the channel.

10. The apparatus according to Claim 8 or 9 wherein the screen material has openings sized to prevent penetration of the particulate materials.

11. The apparatus according to Claim 8, 9 or 10 wherein the screen material includes a pair of flange members extending outwardly therefrom along inside surfaces of the ring members to a position at a base of the recess so as to support the screen material at a predetermined distance from the base of the recess.

12. A centrifuge bowl comprising an outer shell formed from a rigid supporting material including a peripheral wall surrounding an axis of the bowl about which the bowl can rotate to centrifuge materials carried on the peripheral wall, and an inner liner of a cast plastics material mounted on the peripheral wall for rotation therewith, means defining a plurality of ducts through the peripheral wall each

communicating from an open mouth at an inner surface of the liner to an open mouth at an outer surface of the peripheral wall, and a plurality of attachment means for attachment of the inner liner to the peripheral wall, each attachment means comprising a portion of the peripheral wall which is punched inwardly of the peripheral wall towards the axis, said portion defining a U-shaped channel having a base and two legs with the base of the U-shape facing inwardly and the legs of the U-shape integrally attached to the peripheral wall, ends of the channel being open by a severing of the material of the peripheral wall at the ends of the portion, and an insert portion of the cast plastics material of the inner liner which is integral with the inner liner and which extends from the inner liner on the inner surface of the peripheral wall through the ends of the channel and along the channel such that the insert portion lies exteriorly of the portion of the peripheral wall, each of at least some of said ducts extending through the insert portion generally longitudinal of the channel and through one of the ends of the channel.

13. Apparatus for centrifugally separating intermixed particulate materials of different specific gravities in a liquid comprising a centrifuge bowl having a base and a peripheral wall surrounding an axis passing through the base and generally upstanding from the base to an open mouth, axially spaced, inwardly projecting, peripherally extending ring members defined on an inner surface of the peripheral wall so as to provide an annular recess between each ring member and the next adjacent ring member, and a plurality of openings extending through the peripheral wall from an outer surface to the inner surface thereof, the openings being arranged in the recess between each ring member and the next adjacent ring member and in spaced relation around the peripheral wall, means mounting the bowl for rotation about the axis, means for feeding materials into the bowl such that during rotation of the bowl the materials

flow over the peripheral wall for discharge from the open mouth, means for applying fluidizing liquid to the outer surface of the bowl so as to pass through the openings and fluidize the materials in the recesses, and a plurality of substantially annular portions of a screen material each extending across a respective one of the recesses at a position spaced radially outwardly from an innermost edge of each of the adjacent ring members, so as to define a: shallower recess having a base formed by the screen material and sides formed by those portions of the ring members radially inward of the screen material, and spaced radially inwardly of the peripheral wall, so as to define an annular channel between the screen material and the peripheral wall, the openings discharging into the channel.

14. The apparatus according to Claim 13 wherein the annular channel is continuous around each recess and wherein the openings pass through the side wall in a direction inclined to a radius of the axis so as to direct the fluidizing liquid angularly around the channel.

15. The apparatus according to Claim 13 or 14 wherein the screen material has openings sized to prevent penetration of the particulate materials.

16. The apparatus according to Claim 13, 14 or 15 wherein the screen material includes a pair of flange members extending outwardly therefrom along inside surfaces of the ring members to a position at a base of the recess so as to support the screen material at a pre-determined distance from the base of the recess.

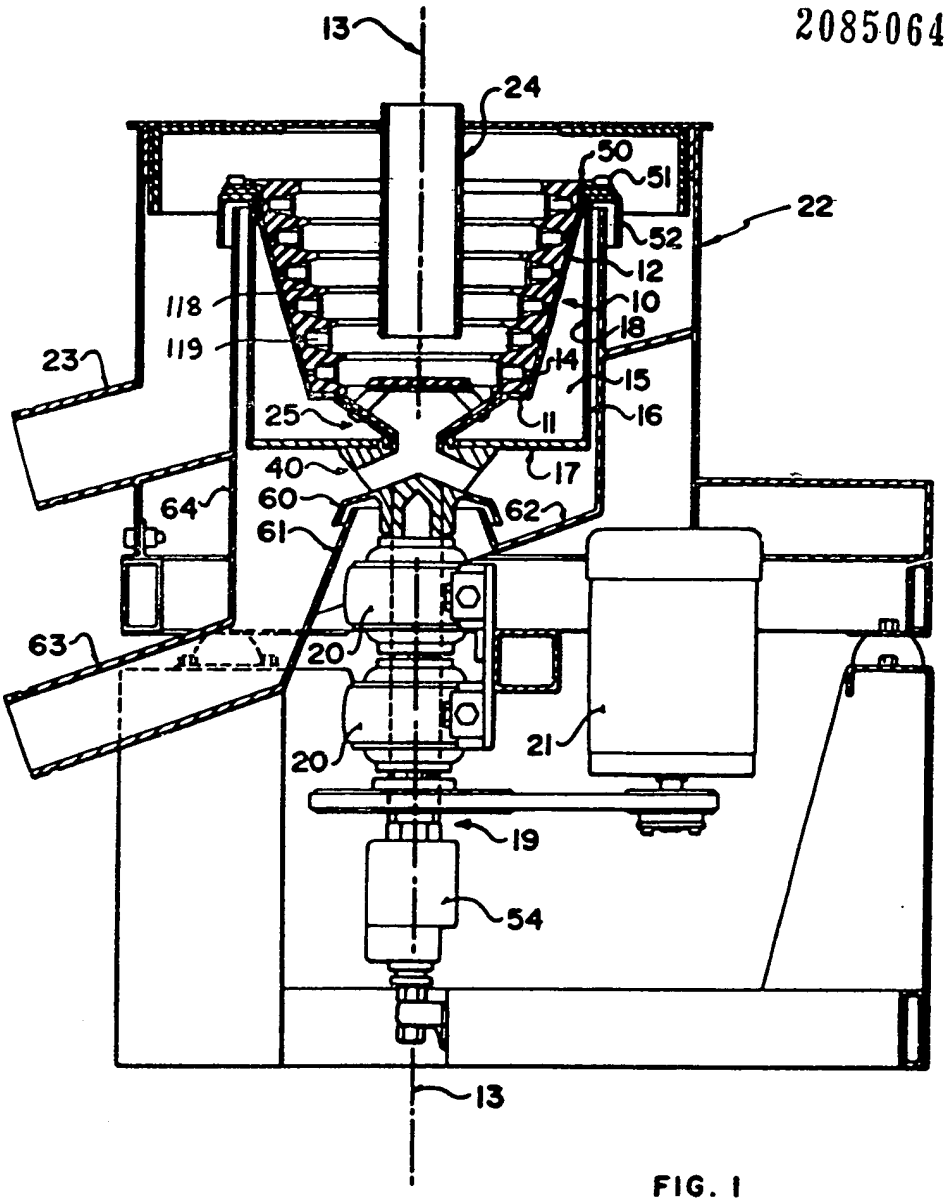

FIG. 1

BENJAMIN V. KNELSON
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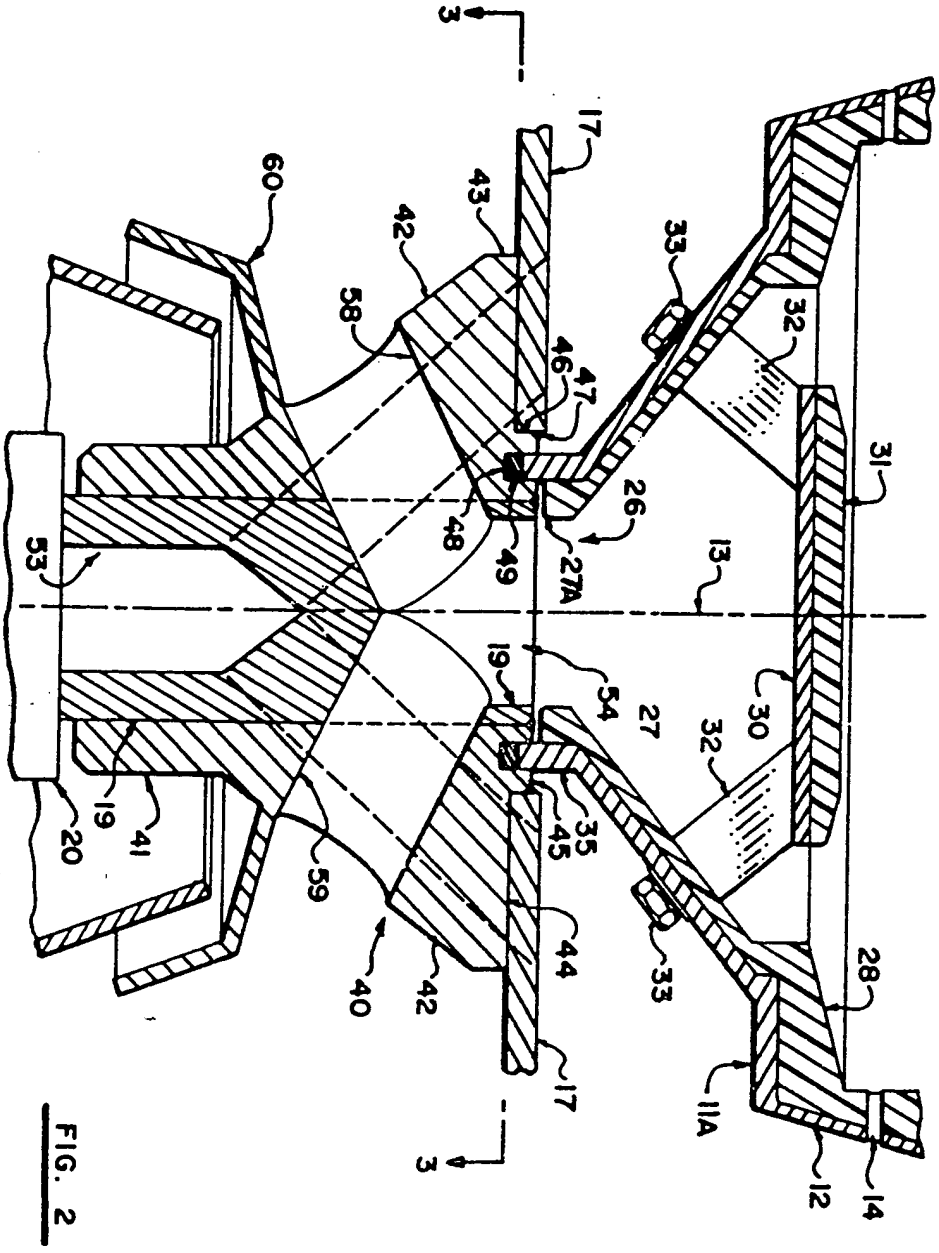

FIG. 2

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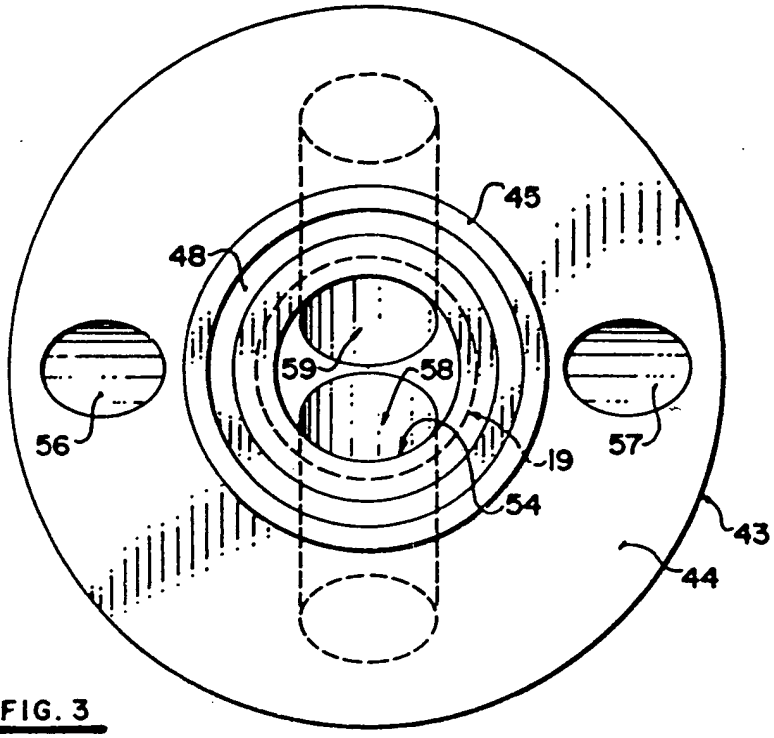

FIG. 3

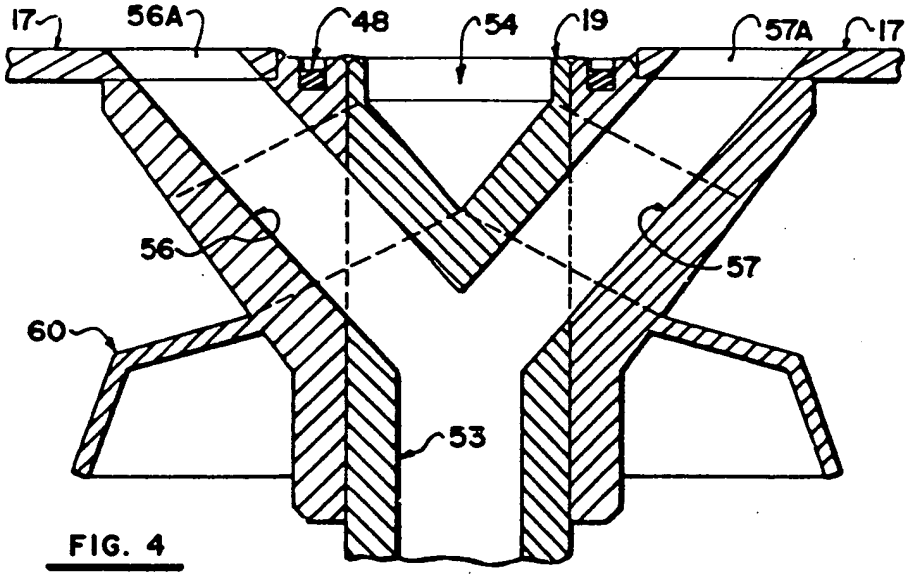

FIG. 4

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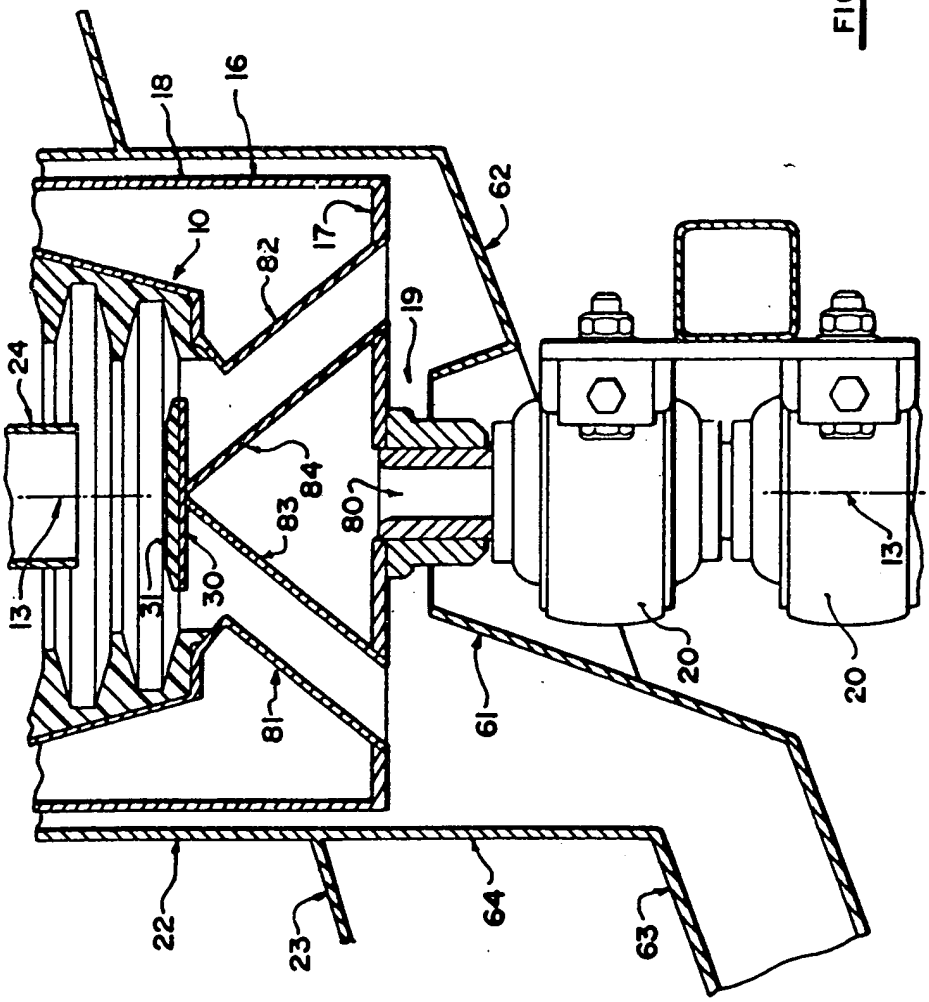
FIG. 5



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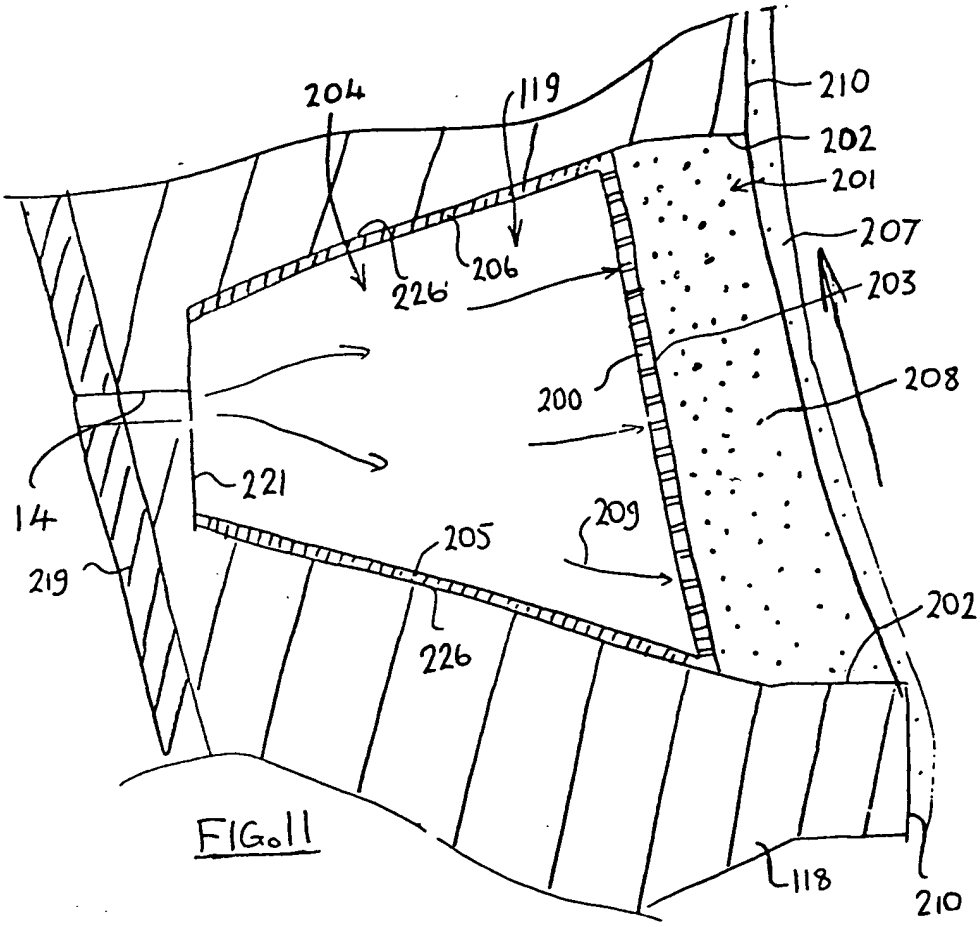

FIG. 11

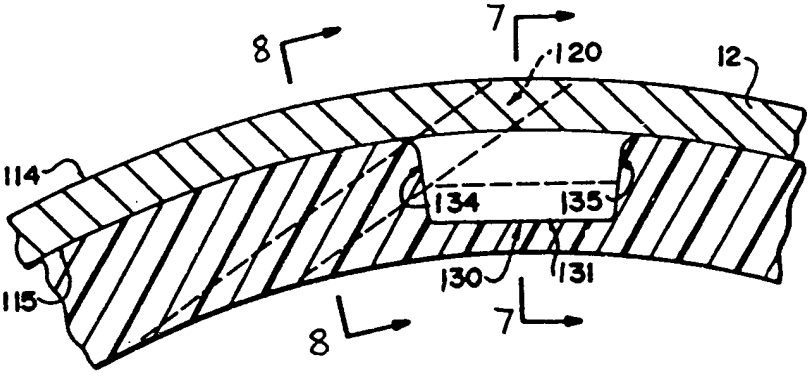

FIG. 6

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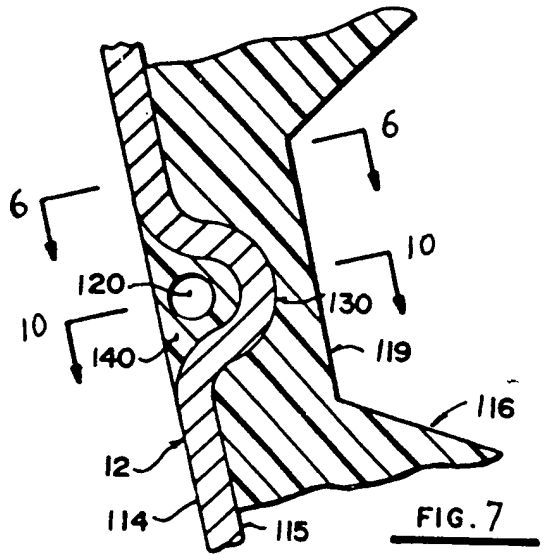

FIG. 7

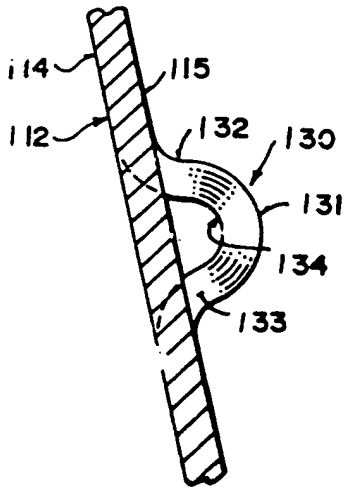

FIG. 8

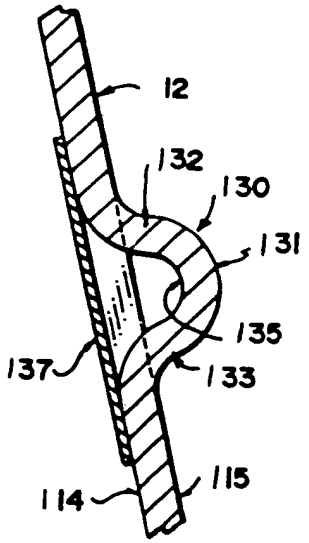

FIG. 9

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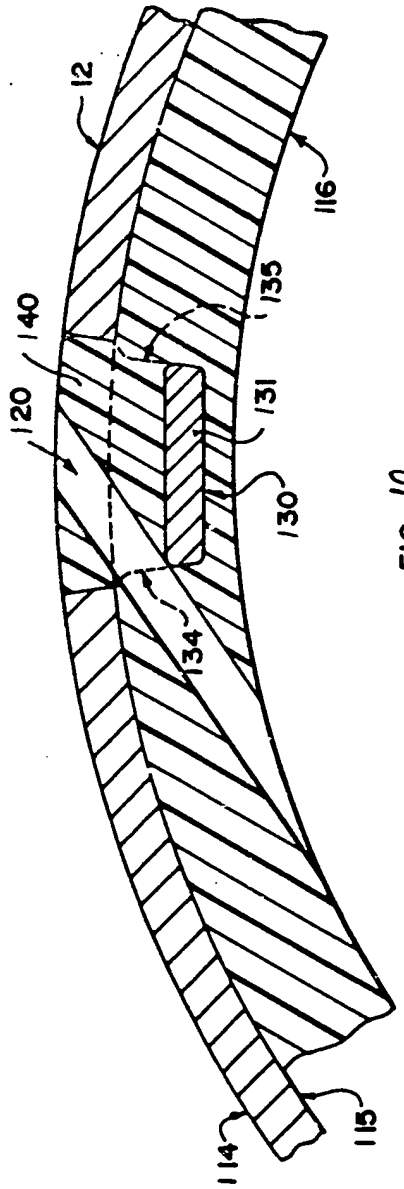

FIG. 10

BENJAMIN V. KNELSON
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